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Anatomy and Surgery in Europe and the Middle East During the Middle Ages

Introduction.

My aim here is to consider the evidence for both anatomical and surgical knowledge in the Middle East and Europe during the medieval period. A large body of excellent research exists that explores medicine at that time. However, some areas are understood much better than others, and some theories from the nineteenth and twentieth centuries are still included in modern texts even though they have been disproved or significantly revised. The Middle East and Europe were distinct geographically, linguistically, and theologically, but the theory that underpinned the understanding of medieval medicine was the same since both regions followed the humoural theory of the ancient Greeks. Despite the known differences between medieval Europe and the Middle East, there was considerable movement of people, translation of medical texts, and practical interaction between medical practitioners from both regions, especially at the time of the crusades. This complex interaction allows us to consider the flow of ideas between cultures, and to compare and contrast how these differing cultures led to variation in the practice of anatomical dissection and surgery.

Anatomy in the Middle East from Umayyad to Mamluk Periods.

Anatomical knowledge was perceived as important in the medieval Islamic world for two reasons. Firstly, medical practitioners realised that surgeons who did not know enough anatomy were likely to do more harm than good when performing operations. For example, the tenth century Andalusian surgical author al-Zahrawi wrote 'for he who is not skilled in as much anatomy as we have mentioned is bound to fall into error that is destructive to life'[1]. The second reason for the study of anatomy was to understand the wonders of God's creation. Al-Gazali (d.1111AD), wrote in Damascus that 'The Naturalists are a group of people who are constantly studying the natural world and the wonders of animals and plants. They are frequently engaging in the science of anatomy/dissection of animal bodies, and through it they perceive the wonders of God's design and the marvels of his wisdom'[2].

Anatomical texts in the early Islamic period followed the Hellenistic models of classical authors. Most of Galen's anatomical treatises were translated into Arabic during the 9th century AD by Nestorian Christians such as Hunayn ibn Ishaq, his son

[1] Savage-Smith 1995, 93.
[2] Savage-Smith 1995, 95.

Ishaq and his nephew Hubaysh. Some texts were also translated into Syriac before the Arabic version was made[3]. This occurred well before the anatomical texts of Galen began circulating in medieval Europe, so we might expect that anatomical knowledge and continued research would have enabled considerable anatomical advances in the medieval Islamic world. However, this does not appear to have been the case. Perhaps the principal anatomical discovery of the Islamic world was that of ibn al-Nafis, who improved upon Greek ideas as to how blood moved through the heart and the lungs[4]. There is as yet no evidence that human cadavers were dissected in the Islamic period, but there were references to the dissection of animals. For example, the Nestorian Christian physician Ibn Masawayh described dissecting an ape (possibly a Barbary ape or baboon) at Samarra near Baghdad in 836 AD and then writing a book on his observations[5]. There were frequent references in Arabic medical texts to the importance of the study of anatomy in order to practice safe bloodletting or surgery, but it appears that such study relied upon reading books rather than performing dissection.

Illustrations of anatomy in Arabic manuscripts were not generally realistic or naturalistic, but stylised and geometric. In this regard, European manuscripts were considerably more lifelike, and therefore perhaps more helpful to the reader. During the medieval period Arabic manuscripts depicted human anatomy using geometric shapes with circles, triangles and squares[6]. Circles were used for eyes and for concentric layers of an organ. Triangles were used to depict non-triangular structures such as the brain and muscles. By the fifteenth century there is a change in style seen in these illustrations that seems to reflect the European approach to depicting anatomy. Copies of the Persian language anatomical tract of Mansur ibn Ilyas's (written in 1388AD) that date from the 1400s show five full-page diagrams of the whole body in a squatting posture. Each system (skeleton, muscles, nerves, veins, and arteries) is depicted separately, and the former geometric triangles and circles start to become more recognisable and natural[7].

Anatomy in Europe During the Medieval Period.

In thirteenth century Europe anatomy was regarded as just one part of the much larger field of natural philosophy (*philosophia naturalis*). This encompassed those aspects of academic study concerned with nature, as created by God. It has been argued that the perceived purpose of anatomical knowledge in medieval Europe was not primarily to advance medical practice (although it did as a fortunate by-product), but rather to advance knowledge of God and his creation. In consequence, anatomical dissection similarly became a highly-formalised, semi-religious event to demonstrate God's greatness[8].

3 Savage-Smith 1995, 86.
4 Pormann – Savage-Smith 2007, 60.
5 Savage-Smith 1995, 85.
6 Savage-Smith 2007.
7 Savage-Smith 2007.
8 Cunningham 1997, 38 and 54.

Cutting into the human corpse was not in itself regarded as objectionable in medieval Europe. Kings and nobles had undergone division of the corpse throughout the twelfth and thirteenth centuries, with the consent of the church. This allowed their bodies to be transported to their preferred place of burial after their death, and made it possible for their heart to be in a casket in one church while their bones lay in another. This resulted in twice as many prayers being said for their soul than would be the case if all their body parts were in the same place[9]. Autopsies were undertaken to try to determine the cause of unexpected death, both for legal reasons and to satisfy the curiosity of the remaining family. There are plenty of examples of autopsy known from the late thirteenth and early fourteenth centuries in Bologna and other cities in northern Italy[10].

A variety of written sources of anatomical knowledge were available in medieval Europe. Translations of Arabic texts discussing anatomy were in circulation, such as the Isagogue of Johannitus (Hunayn), the Canon of Avicenna (Ibn Sina), the Pantegni of Constantinus Africanus (original author al-Majusi) and the ninth book of the 'Almansor' by Rhazes (al-Razi). A commentary on Galen's 'On the Usefulness of the Parts of the Body' was also in Bologna by the end of the thirteenth century[11].

In Italy from around 985 to 1225AD the dissection of pigs was undertaken at Salerno for the purpose of teaching anatomy to students studying medicine. This resulted in the twelfth and thirteenth century anatomical manuals such as Anatomia Porci, Anatomia Mauri, Anatomia Ricardi and Anatomia Magistri Nicolai[12]. These texts noted how dissection of the pig was particularly useful for improving knowledge of human anatomy, since the internal organs of the pig resembled human anatomy much better than other available animals.

However, from the early thirteenth century, the teaching of human anatomy in Europe underwent a major development. Mondino de Liuzzi (born c.1270, died 1326) was a professor of medicine at Bologna, and he wrote his text Anatomia in 1316 as a handbook to accompany dissection on the cadavers of criminals executed by hanging or beheading. Mondino used five of Galen's texts that refer to the importance of anatomy, namely De Sectis, De Usu Partium, De Juvamentis Membrorum, De Interioribus, and Tegni[13]. He is known to have supervised dissections, with the practical aspects delegated to a surgeon assistant. The dissection started with a large cross-shaped incision in the abdomen, presumably because this was the first part of the body to decompose. The dissection took place over three days, with Mondino, sat in his high professorial chair, reading out the Latin text while his assistant demonstrated the organs at the appropriate moment[14]. This form of anatomising was to become the model for the whole of Europe for the next two centuries.

Surgery in The Middle East from Abbasid to Mamluk Periods.

9 Brown 1981; Park 1995.
10 O'Neill 1976; Park 1994; Park 2006.
11 Siraisi 1990, 84.
12 O'Neill 1970; Corner 1927; Cunningham 1997, 37.
13 French 1999, 37.
14 Cunningham 1997, 42-3; Siraisi 1981, 66-9; Olry 1997.

During the Abbasid period (750-1258 AD) the surgical texts of Greek authors such as Galen (2nd century AD) and Paul of Aegina (7th century AD) were identified in libraries in Alexandria and elsewhere and translated into Syriac and Arabic by Christians and Arabs[15]. One of the best-known translators of this time was the Nestorian Christian physician Hunayh ibn Ishaq (died c.873). Such translations led to further intellectual development of the field of surgery with the writing of commentaries on these works. Paul of Aegina was extensively used by al-Razi (Rhazes), al-Baladi, Ibn Samagun, al-Majusi (Haly Abbas), al-Zahrawi (Albucasis), and Ibn Sina (Avicenna) in their writings[16]. This flowering of Arabic medical writing could be argued to peak around the 10th century AD. Perhaps the most influential Arabic surgical text was the surgical section of *Kitab al-Tasrif,* written by Abu al-Qasim al-Zahrawi (936-1013AD) in Cordoba, Andalusia around 1000AD. This became well known for its illustrations of surgical instruments, and the choice of wording that conveys a sense of personal surgical experience by the author[17]. However, in the ninth to eleventh centuries, Arabic writing on surgery is generally found as a chapter or section within larger works on the broader field of medicine.

The first medieval Arabic treatise composed just for surgeons seems to have been the *Basics in the Art of Surgery*. This was written in the thirteenth century by the Damascene physician Ibn al-Quff (d.1286). The work included sections on anatomy, medicines, and surgical cases such as wounds and tumours. Although today we might expect eye surgery to have been included in such a surgical work, he did not cover the topic as he felt it to be outside his own specialty[18]. There were plenty of treatises devoted specifically to the treatment of eye diseases, which generally included both medical and surgical treatments. Some of the better-known works are Hunayn's *Ten Treatises on the Eye* in the 9th century, Ali ibn Isa al-Kahhal's *Memorandum Book for Oculists* in the 10th century, and more eye treatises were written in the 12th and 13th centuries in Spain, Egypt and Syria[19].

Surgical training in the Arab-speaking world could be acquired from a father training his son, from working as an apprentice to a respected surgeon in the regional centre, from academic study of written texts, and working in hospitals[20]. Regulation of surgeons was undertaken by the *Muhtasib*, the market inspector responsible for ensuring fairness and honesty in all forms of trade by craftsmen and businessmen. *Hisba* manuals were written outlining what standards were expected of surgeons and others in the market place. The twelfth century *hisba* manual of al-Shayzari required that surgeons possessed at least one set of scalpels, lancets, a saw, ointments and dressings. Blood-letters had to carry lancets, oil for the skin, string to tie around the arm, and musk to revive any patient who fainted. Oculists were to own hooks, scalpels, a scour and eye ointments[21]. When a student had completed a period of study of a medical text under a well-known scholar, their copy of the book

15 Greppin – Savage-Smith – Gueriguian 1999.
16 Pormann 2004, 311-2.
17 Spink – Lewis 1973; Pormann – Savage-Smith 2007, 61.
18 Pormann – Savage-Smith 2007, 61.
19 Pormann – Savage-Smith 2007, 65.
20 Leiser 1983.
21 Al-Shayzari 1999.

could be signed to confirm they had mastered the knowledge contained within it to demonstrate their level of expertise. Galen, Hunayn and al-Razi all wrote texts on the examination of physicians, and these were in circulation in the Islamic world during the medieval period to give guidance to those whose responsibility it was to determine fitness to practice[22]. Some *hisba* manuals referred to specific medical texts that were felt to encompass the standard of knowledge required for different surgical specialties to practice safely. For example, Hunayn's *Ten Treatises on the Eye* was a typical text employed in the examination of oculists, the musculoskeletal section of Paul of Aegina was widely used for bonesetters, while Galen and al-Zahrawi on wounds were used for the assessment of surgeons[23].

The tenth and early eleventh century medical texts of al-Razi, al-Majusi, al-Zahrawi, and Ibn Sina mentioned above are generally accepted to be academically more complex than both the ancient Greek sources upon which they were based, and those texts being written in Europe at that time[24]. As a result, it has been widely assumed by modern academics that surgery and medicine in the Middle East was particularly advanced during the middle ages. These texts were certainly large and intellectually impressive for their time, as they explored the theory of medicine. However, there is very little evidence to suggest that the academic context of these texts had much impact upon the practice of medicine and surgery by the average medical practitioner working in the Middle East[25]. This calls into question the assumption that the existence of intellectually advanced medical texts among the elite medical practitioners in the courts of the sultans signifies that most doctors of the time were practicing intellectually advanced surgical treatments themselves.

Study of the medical texts of Arabic speaking practitioners such as al-Razi has found that those authors may have written about complex operations in their academic texts, but in their collections of case histories they generally treated surgical conditions with medical rather than surgical treatments[26]. Sometimes the authors' mention that an operation included in their text had been described by the ancients (Greeks), but that they had never performed it, or even seen it used by others. There often seems to have been a reluctance to use surgical techniques if they could be avoided, which is a quite striking contrast between theory and practice[27].

The paucity of archaeological examples for surgery to bone in the Middle East during the middle ages, compared with the many examples excavated from medieval contexts in Europe (see below), could be argued to support the view that surgery was probably not employed as much in the Islamic world as was the case in medieval Europe. However, we should remember that only a small fraction of the number of excavations of human skeletal remains have taken place in the Middle East than is the case for Europe. The absence of archaeological evidence for surgery in the Middle East may just reflect the cultural context of the region today, where burials are generally not the target of excavations.

22 Iskandar 1962; Karmi 1979.
23 Al-Shayzari 1999, 116-7; Karmi 1979; Levey 1963.
24 Fischer 2000; Meaney 2000; Wallis 2000.
25 Mitchell 2004, 212-7.
26 Alvarez-Millan 2000.
27 Savage-Smith 2000.

Surgery in Europe During the Medieval Period.

Textual evidence for surgical procedures in Europe becomes common from the twelfth century, when the 'rational surgery' movement starts to develop[28]. This does not, of course, mean that surgery was not taking place in Europe before this time, just that evidence for it in medical texts is extremely limited. For example, there is plenty of evidence for cranial surgery in south-western Germany in excavated skeletons dating from the 6th-8th century AD[29]. Since there are no surviving surgical texts from 6th-8th century Germany, we would be unaware of this surgical activity were it not for the archaeological evidence. We remain ignorant of any surgery to soft tissues that may have taken place in the same time period, as these tissues have decomposed a long time ago.

Until the twelfth century many operations were performed by general doctors referred to as *medici*. By the end of the twelfth century we start to see terms in manuscripts that differentiate separate specialties within medicine. The *cyrurgicus* was the term describing the surgeon, the *barberus* referred to the less educated barber, while *minutor*, *phlebotomus* or *sanguinator* indicated the blood-letter.

Surgical training would have varied depending upon the social status and geographic region of Europe from which the student came. Many surgeons would have trained via the apprenticeship method from their father. However, some medici would have studied the theory of medicine for many years before earning the title of *magister* ('master') in a centre of learning such as Salerno. By the mid 1200s universities in northern Italy such as Bologna and Padua were granting degrees to students specifically studying surgery (rather than the entirety of medicine), and so from that time it was the possible to train to be a master surgeon. Training started in the liberal arts, namely grammar, rhetoric, logic, arithmetic, astronomy, geometry and music. After several years the title of master was awarded, and the student was able to pursue further studies in medicine to become a *physicus*, *medicus* or *cyrurgicus*. However, it was not possible to become a master surgeon at northern European universities such as Paris, Montpellier, or Cambridge, as there university training was limited to the clergy who could become master physicians and *medici*, but not surgeons[30].

Medical licensing and negligence legislation seems to have its origins in Europe in the twelfth century. In 1140 the Assises collection of Roger II of Salerno stated that doctors were required to undergo examination before they were given a licence to practice in the Kingdom of Sicily[31]. Licensing for surgeons and other medical practitioners then became more widespread across Europe during the twelfth and thirteenth centuries. The legislation of Emperor Frederick II Hohenstaufen in 1231 required doctors to provide written proof that they had completed the required number of years study, as well as passing an examination. Those who practiced without a licence were imprisoned for a year and had their belongings confiscated[32]. A large

[28] McVaugh 2006.
[29] Weber – Czarnetzki 2001.
[30] McVaugh 2000; Siraisi 1981; O'Boyle 1998.
[31] Liber Augustalis 1854, 149-50.
[32] *Liber Augustalis* 1854, 149-50; Hartung 1934; Sigerist 1935.

number of the licenses for surgeons from Naples have been identified studied[33]. In Paris in the 1250s the city provost formed a panel of respected surgeons who examined those who wanted to practice surgery in the city[34]. By the later thirteenth century we start to see increasing records of court cases for alleged medical negligence across Europe[35]. By the fourteenth century we also see medical malpractice insurance available for high-risk cases[36].

Many surgeons worked on a fee for service basis, but some could rely on a more regular income. By the twelfth century we hear of Italian cities contracting surgeons to look after their inhabitants, for a fixed yearly salary. These surgeons would also accompany the soldiers of that city should they go to war or crusade. The earliest example of this arrangement for which records have come to light is that of Hugo of Lucca, whose contract was with the city of Bologna. In 1216 he was paid 600 Bolognese lira per year to attend to the surgical needs of the inhabitants[37].

Other surgeons with an excellent reputation were able to join the entourage of a king or noble, so that for a regular salary they would attend their employer whenever required. Records of such surgeons often demonstrate the degree to which their salary was higher than barbers or apothecaries in the same entourage. For example, in 1261 the surgeons Guillaume de Salu and Pierre de la Broce were both paid 24 deniers per day (and 6 extra when at court) to be in the service of King Louis IX of France. In the same year, Jean the barber was paid 6 deniers per day for his service to the king[38].

Many twentieth century medical history books state that the clergy in Europe were not allowed to practice surgery, quoting the phrase *ecclesia abhorret a sanguine* (the church abhors the shedding of blood). However, it has been noted that this quote does not appear to have come from a medieval document, but is a modern phrase created to summarise our perceptions of medieval views[39]. It seems that up until the twelfth century the practice of surgery was permitted to everyone, including the clergy. In 1163 the Council of Tours forbad clergy in religious orders from leaving their monasteries and abbeys to study medicine in a secular environment[40]. It was not the practice of surgery that was the concern, but the time spent away from their religious house. The secular clergy could still study medicine, and the religious orders could still study it within their own institutions. In 1215 the Fourth Lateran Council forbad certain clergy (subdeacons, deacons and priests) in religious orders from practicing surgery involving incisions or cautery, as it was believed to preclude them from saying mass[41]. There was no prohibition against the practice of surgery by the secular clergy who were not in religious orders, nor was there any problem with the practice of surgery by those in religious orders where no blood was shed by the surgeon, such as splinting fractures or bandaging wounds.

33 *Fonti per la Storia* 1962.
34 Bullough 1958; Jacquart 1994.
35 Cosman 1972; Post 1972; Cosman 1973; Schatzmiller 1989.
36 Cosman 1982.
37 Sistrunk 1993; Nutton 1979.
38 Mitchell 2004, 43.
39 Talbot 1967, 55.
40 *Sacrorum Conciliorum* 1776, XXI, col.1179, canon 8.
41 *Disciplinary Decrees* 1937, 258, canon 18.

Ruggiero Frugardi of Parma taught surgery in the late twelfth century and his students wrote down his teachings in what was to become the first European surgical text of the medieval period. This *Chirurgia* was the first in a series of around a dozen progressively larger and more complex surgical texts that together represent the rational surgery of the Middle Ages[42]. They were written in Latin with the aim of making surgery an academic subject equal in importance to the art of medicine studied by the *physici* of the time. Specialist technical terminology was created, and scientific reasoning was given to explain the cause of surgical diseases and how they should be treated. The movement started in northern Italy around 1230 and over the following century also spread to France. Key surgical texts in this movement were written in Italy by Rolando of Parma in 1230, Bruno Longobucco in Padua in 1252, Teodorico Borgognoni in Bologna in the 1260s, and Guglielmo of Saliceto in Bologna and Verona in the 1270s. In France we see the creation of the surgical text of Lanfranc of Milan in Paris the 1290s, and of Henri of Mondeville 1310s in Paris and Montpellier[43]. The end of the rational surgery period was heralded by Guy of Chauliac (flourished 1350). He had been taught in the Italian tradition by Niccolo Bertrucci, a student of Mondino dei Liuzzi. Guy's surgical text was completed by 1363, and was soon translated from Latin into French, Provençal, Catalan, Dutch, English, Irish and Hebrew. It was still used in Paris in the 1490s when the faculty there taught barber surgeons[44]. We can see that during the150-year period from Ruggiero Frugardi to Guy of Chauliac surgery had created for itself an academic, scientific discipline in southern Europe. However, surgeons were unable to build upon this as time passed so that the physicians came to dominate the hierarchy of universities across Europe. Surgery became a progressively less academic and lower status profession due to its practical nature, to again revert to being a career largely taught via apprenticeship.

Archaeological evidence for surgery helps us to understand what operations really were being undertaken, so allowing us to clear up the debate as to whether there was a major contrast between theory and practice. Such evidence can be found with the excavation of surgical instruments in medieval contexts, and also with the marks of straightening, cutting, sawing or drilling human bones. Evidence for the manipulation and splinting of long bone fractures can be found from a comparative study of two cemeteries in medieval Britain[45]. The cemetery of St Margaret Fyebridgegate in Norwich was in use between 1245 and 1468. It was the cemetery for a poor area of the town and for the criminals executed by hanging at the gallows. Forearm fractures were noted to have healed and an angle, and had not been returned to a more normal alignment by manipulating and splinting. In contrast, the cemetery of St Helen-on-the-Walls at York was in a more affluent area, but was in use over a similar time period (1100-1550). In this cemetery the forearm fractures were noted to have usually healed reasonably straight, suggesting that they have been manipulated and held still with a splint applied by a medical practitioner of some kind. Similar findings from the Anglo-Saxon period have been used to argue that effective manipulation of frac-

[42] McVaugh 2006.
[43] McVaugh 2006, 14-52.
[44] French 1999, 65.
[45] Grauer – Roberts 1996.

tures was taking place then too[46]. Sometimes metal plates have been recovered from burials where they have been used to splint a joint. For example, copper alloy plates, padded with leather and held in place with thongs or twine, appear to have been used as a splint to support an injury at the knee in a skeleton from 13th-14th century York[47].

Surgical procedures requiring incisions were also taking place in Europe during the medieval period. Trepanation, where a section of the cranium is surgically removed by scraping, cutting or drilling, has been found at many excavation sites. In most parts of Europe during the medieval period trepanation was undertaken in less than 1% of skeletons, although understandably its use would have varied over time and between regions. In 6th-8th century south-western Germany 10% of crania with blade wounds showed signs of trepanation, which represents 1% of all skulls[48]. Medieval skeletons excavated from Tiermes (Old Castilla) in Spain demonstrate a 5% prevalence of trepanation[49]. In some European examples large sections of the cranium were removed and healing at the edges confirms the individual survived the procedure[50]. An alternative approach to skull wounds has been identified in a 12th-13th century skull from Jewbury in York (Britain)[51]. The skull shows evidence for a sword wound, and evidence for surgery is provided by cut and scrape marks on the adjacent bone. The marks were created while the individual was alive as there are signs of healing present. The cut marks have been interpreted as indicating incision and retraction of the scalp, while scrape marks along the edges of the sword wound suggest the wound was explored and widened in order to remove any splinters of bone, as recommended in surgical texts of the time. Such examples demonstrate that cranial surgery was widely practiced in medieval Europe in different regions and time periods.

Cauterisation is a surgical technique employed during the medieval period where a heated rod of metal was applied to the surface of the body in order to burn it. Cautery was believed to be useful in the treatment of a wide range of conditions[52]. In areas of the body where bone lies close to the skin, cauterisation could in theory leave changes to the bone that might be detected in excavated skeletons. From a range of excavations of skeletal remains from medieval Oslo in Norway, 24 crania were noted to have smooth, oval indentations in the outer table of the bone[53]. There was an inflammatory reaction around them, indicated by bone porosity. The location of most of then was identical, being the top of the forehead in the midline (the bregma). Some of the skulls possessed two such indentations, with the second being in the midline on the back of the cranium. Since these are locations for cauterisation described in medieval medical texts[54], it has been argued that the lesions most likely

46 Wells 1974.
47 Knüsel – Kemp – Budd 1995.
48 Weber – Czarnetzki 2001.
49 Reverte 1980.
50 Thurzo – Lietava – Vondakova 1991.
51 Lilley – Stroud – Brothwell – Williamson 1994, 480-6.
52 Albucasis 1973 16-8.
53 Holck 2002.
54 Albucasis 1973, 16-8.

indicate cauterisation where the hot iron was applied to he scalp for long enough to cause changes to the underlying bone[55].

Copper plates have been found applied directly to the bone in individuals whose skeletons were recovered from several medieval cemeteries[56]. The shape and position of the metal implants coupled with bony reaction demonstrates that they can only have been applied at the time of an operation during the individual's lifetime. All these examples demonstrate that surgical procedures involving bone were being undertaken in medieval Europe. Archaeological excavation of skeletons cannot provide us with evidence for surgery involving just the soft tissues, so it is highly likely that the total amount of surgery taking place in medieval Europe would have been considerably larger.

Surgery in the Crusades: where Europe and the Middle East Met.

A fascinating area of medieval history where the cultures of Europe and the Middle East interacted was the crusades and the resulting states that were set up by European settlers in the eastern Mediterranean (1099-1291). A significant number of surgeons from France, England, Italy and other areas are known to have gone on crusade to the Holy Land, as they were recorded in documents written both in Europe and in the east[57]. Some worked for kings or nobles, others were under contract with Italian cities, but the majority seem to have been independent surgeons working on a fee for service basis.

Surgeons are noted to be working in the hospitals of the Order of St. John by the 1180s, when four are recorded in documents describing the hospital in Jerusalem[58]. The surgeons also staffed a mobile field hospital that accompanied the army of the King of Jerusalem on military campaigns. They treated the injured in tents, and carried the more severe casualties back to their larger hospitals on pack animals for further treatment[59]. Blood letters are also recorded as working in the hospital in Jerusalem at that time, both treating sick patients and also prophylactically bleeding members of the order as was customary at that time. Examples of the treatment of weapon injuries described in crusader sources include the extraction of arrows, applying splints for fractures, wound closure for lacerations, hot cautery iron to prevent heavy bleeding, and dressings for burns[60].

While it is understandable that crusaders sustaining wounds would have been treated by surgeons, there is also evidence for planned surgical procedures taking place in the Frankish states of the Latin East. There are records describing bloodletting, limb amputation for chronic disease, scalp surgery for mental illness, draining excess fluid from the abdomen in ascites, haemorrhoid treatment, draining an abscess, and the trimming of overgrown gum tissue in scurvy[61]. The types of surgery

[55] Holck 2002.
[56] Hallback 1976-77; Janssens 1987.
[57] Mitchell 2004a, 17-31.
[58] Edgington 1999.
[59] Kedar 1998.
[60] Mitchell 2004a, 137-83.
[61] Mitchell 2004b.

described appear to have been relatively low risk to the patient, as no examples of planned major surgery to the contents of the chest, abdomen or pelvis are recorded.

Medical negligence laws from the Kingdom of Jerusalem have also survived, dating from around 1244[62]. These mention court cases where surgeons were found to have been negligent in their treatment. Examples of negligent surgical procedures included allowing a long bone fracture to heal angulated due to poor plasters, causing death by over zealously burning haemorrhoids at the anus with a cautery iron, cutting into an abscess the wrong way, and failing to remove fragments of broken bone in a serious head wound. It was also regarded as negligent for a surgeon to apply heating ointments when cooling ointments should have been used, to modify diet in a way that contravenes medieval theory regarding humoural balance, or to fail to attend every day if the patient then died. If a surgeon was convicted of negligent treatment causing the death of a slave they would have to pay the owner the cost of the slave, but if the patient was a free man the surgeon was to be hung[63].

Analgesia and Anaesthesia.

The use of painkillers and anaesthetics by medieval surgeons is not well understood. Surgical texts from both Europe and the Middle East frequently include sections on these medicines, but it is much less common to find reference to their use in non-medical texts that happen to mention operations taking place. This may mean these drugs were not routinely used, or it may mean that they were routinely used, but just not mentioned as the author felt that describing them was not relevant to the story they wanted to record. The plants most often described for their pain relieving or sedating properties were the opium poppy, henbane, hemlock, deadly nightshade and madragora root[64]. These have all been shown to contain compounds that are the same, or very similar to, many of the drugs used in anaesthesia today[65]. For example, in the early eleventh century Ibn Sina (Avicenna) described how the plants were boiled in water or wine to extract the efficacious components, and the liquid drunk in order to induce sedation or unconsciousness prior to surgery[66]. This approach was also described in a number of written sources from late medieval England and was known as dwale[67].

An alternative method has been described via which the medicines might be taken into the body to induce sedation or pain relief. The soporific sponge was detailed in European medical texts from the ninth century AD[68]. The treatment involved boiling down the sedating plants in wine and then adding a sponge that would then absorb the efficacious components. The texts then advised storing this sponge until needed, and then soaking it in hot water and holding that under the nose of the pa-

62 Brittain 1966; Amundsen 1974; Mitchell 2004a, 220-31.
63 Nutton 2004.
64 Theodorich Borgognoni 1498, 146r; Avicenna 1930, 526-7.
65 Juvin – Desmonts 2000.
66 Avicenna 1930, 413.
67 Voigts – Hudson 1992; Carter 1999.
68 Deffarge 1928; Olivieri 1968.

tient to breath in the fumes until they became drowsy[69]. One modern study tested the effect of the sponge upon laboratory rodents and found that a proportion became drowsy but none fell asleep[70]. The authors argued that since none of the rodents fell asleep, the treatment did not work. However, the fact that some rodents did become drowsy actually does argue for some efficacy after all. Further evidence to suggest that the soporific sponge was used and did have some sedating effect is found in the thirteenth century surgical text of Teodorico Borgognoni. This text strongly argues the merits of the soporific sponge with the words, 'the composition of a saviour to be made by a surgeon, according to Master Hugo, is as follows…'[71]. However, of particular interest is that in a different section of the book, on the treatment of head injuries, Teodorico warns against using the sponge before operating as some patients would not wake up afterwards. He writes that, 'it is impossible to apportion the medication accurately in accordance with the condition of the wounded'[72]. Significant head injuries commonly cause sedation or loss of consciousness, so it is quite understandable that sedating medicines given to someone with a head injury would be more likely to make the patient deeply unconscious and so result in loss of the drive to breath and then to death. Teodorico's enthusiasm for the soporific sponge prior to most surgery, but his warning against its use in head injuries, suggests that the sponge was being used, and its side effects in head injuries had been noted.

There is no doubt that plants containing compounds known to cause sedation and relieve pain were recognised in Europe and the Middle East in the medieval period. Medical texts in both regions describe incorporating them into liquids based upon water or wine, and also concentrating them onto a sponge. However, it remains unclear how widely these medicines may have been used to make surgical procedures more comfortable. It is also unknown how effective they may have been, and how safe they were for the patient, using medieval techniques of drug preparation.

Conclusion.

Anatomical knowledge in medieval Europe and the Islamic world demonstrates a fair number of similarities. Both regions relied heavily on the earlier work of classical medical practitioners such as Galen, and both regarded the study of anatomy as a way in which to understand the wonders of the world as created by God. In both regions, the benefits of anatomical knowledge to surgeons seem to have been a bonus, rather than the primary reason to study human anatomy. Contrasts in anatomical study in the Middle East and Europe have also become apparent. While copies of classical Greek anatomical texts were available in the Middle East well before they were translated into Latin for European readers, the Islamic world did not seem to make maximal use of them. There was some dissection of animals in the east, but most of their learning came from texts rather than practical dissections. These texts also used geometric illustrations, rather than lifelike images of human organs that might help a surgeon. In contrast, dissections of the pig and then humans in Italy

[69] Theodorich Borgognoni 1498, 146r.
[70] Infusino – O'Neill – Calmes 1989.
[71] Theodorich Borgognoni 1498, 146r.
[72] Theodorich Borgognoni 1498, 115r.

gave access to the shape, colour, consistency, and position of internal organs for both anatomists and surgeons. The anatomical images in medieval European texts were also much more lifelike than is the case in Islamic texts. On both accounts, it seems that anatomical exploration was more active, and hence more advanced, in medieval Europe than was the case in the Middle East at that time. This has persisted through the renaissance to the enlightenment[73].

Surgical theory and practice is a more complex area when comparing medieval Europe and the Middle East. Translation of classical Greek surgical texts certainly gave the Islamic world a wealth of textual sources from the 9th century onwards. Unlike the anatomical texts discussed above, Islamic authors created an impressive body of new surgical literature and commentaries by the 10th century. However, research suggests that the advice written within these Arabic surgical texts was not necessarily put into practice even by the same scholars who wrote them, as often non-surgical treatments were employed rather than operative interventions. In other words, the content of these advanced Arabic surgical commentaries probably don't indicate what the medical practitioners were doing in reality, and they may well have been choosing less risky treatments instead of heroic operations. Once Europeans had access to Latin translations of Arabic surgical texts from the eleventh century, they established an academic genre in Italian universities that is now known as the 'rational surgery' of the Middle Ages. Archaeological excavation of human skeletal remains from medieval Europe has demonstrated that a considerable amount of surgery was being undertaken. However, the paucity of excavations of human skeletons dating from the medieval Middle East prevents the archaeological evidence demonstrating what the textual sources find so difficult, namely an impartial estimate of surgical practice rather than theory in both regions.

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Abstract: In the medieval Middle East and Europe anatomy was viewed as an important tool with which to understand the glory of God as manifested through the healthy human body, and the knowledge also helped medical practitioners in their efforts to treat the sick. Translations of classical Greek texts into Syriac, Arabic, Latin, and European vernacular languages coupled with dissection of animals and human corpses enabled a more widespread dissemination of anatomical knowledge. Surgery was practiced by simple bone-setters, oculists and blood-letters as well as surgeons who created a body of academic surgical literature. In the medieval period medical licensing was introduced, and along side it medical negligence legislation and malpractice insurance. Contentious and often misunderstood issues will be explored such as attitudes of the Muslim world to dissection, of the Christian church to clergy performing surgery, whether complex operations in texts were ever undertaken, and whether analgesia and anaesthesia were really employed during surgery.

***Keywords*:** anatomy, Europe, medieval, Middle East, surgery.